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# Assumptions in the Crop Sector: A Review

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# Assumptions in the Crop Sector: A Review

## **Abstract**

The purpose of this paper is to elaborate on the basic assumptions that have been made or need to be made before the solutions for the 1985 RCA (Resource Conservation Act.)

This paper will state the regions to be used in the programming and the assumptions used in the creation of the crop sector. It will examine technology and demands.

## **Disciplines**

Agricultural and Resource Economics | Agricultural Economics | Economics

Preliminary Draft

ASSUMPTIONS IN THE CROP SECTOR

A REVIEW

by

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State University.

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This paper will state the regions to be used in the programming and the assumptions used in the creation of the crop sector. It will examine technology and demands.

### Regions

There are numerous sets of regions used in the programming models built for the 1985 RCA. These include data collection regions, crop producing regions, marketing and livestock producing regions, and range producing regions.

#### Data collection regions

There are several data collection regions used in the CARD/RCA programming models. The smallest collection regions used in this effort are counties. However, very little information is available at this level of aggregation. County data collected from the census and USDA's yields will be used.

The second set of regions used will be the Major Land Resource Areas (MLRAs) (Figure 1). Two sets of information will be used at this level of aggregation -- the 1982 National Resource Inventory (82NRI), and the information from Erosion Productivity Impact Calculator (EPIC). For the 1985 RCA, several adjustments have been made to the MLRAs. MLRAs 12, 58c, 60B, and 66 have been incorporated into 43, 58A, 54, 60A, and 64, respectively. In addition, MLRA 128 has been split into 128N and 128S,

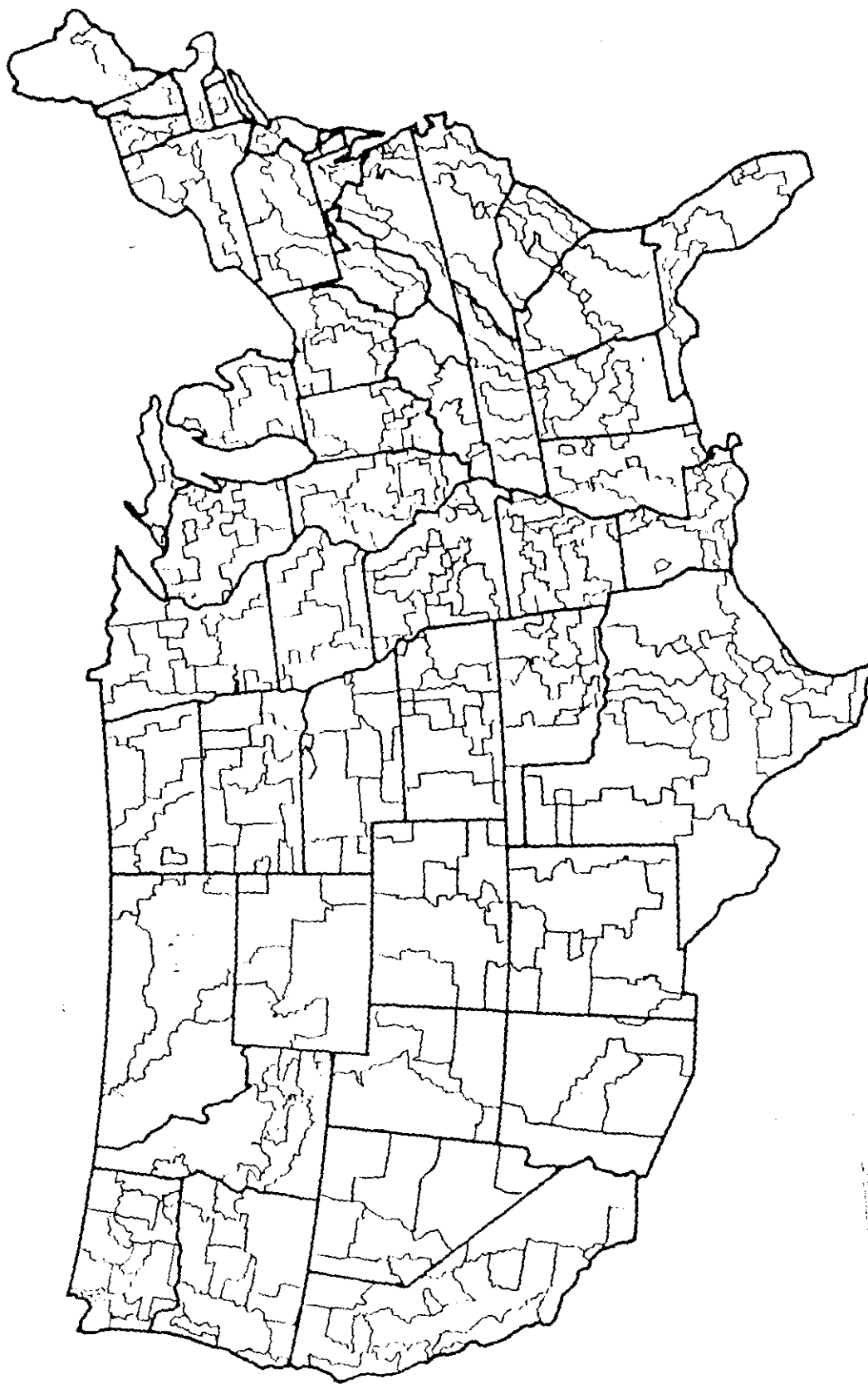


Figure 1. Major land resource areas with state boundaries

MLRA 135A has been split into 133N and 133S at the North/South Carolina border; MLRA 136 has been split into 136N and 136S at the North/South Carolina border, and the 153A has been split into 153N and 153S at the

The third set of data collection regions are the subareas developed by the Water Resources Council. Data from the Second National Water Assessment and from the 1978 Census are collected at this level of aggregation and used primarily in constructing the water Sector (Figure 2).

A fourth set of information is at the Bureau of Economic Analysis (BEA) aggregation level. These data provide information for the methodology used in determining nonagricultural land demands as well as population. The population data are used in distributing per capita commodity demands.

The fifth set of regions used is the Forest Service's potential natural communities (PNC). The data on the range sector are based on these regions. These data will be aggregated to the Ecosystem level.

The final set of information will come from state data.

#### Crop producing regions

The model will contain 105 producing areas (PA) which are the same as the 99 aggregated subareas (ASA) of the U.S. Water Resources Council, except six ASAs are subdivided (Figure 3). Crop producing activities and water supply activities will be built for these regions.

#### Marketing and livestock producing regions

The 105 PAs are aggregated into 31 market regions which serve as the smallest breakdown for the commodity demands, transport linkages, and livestock production and input purchasing activities (Figure 4).

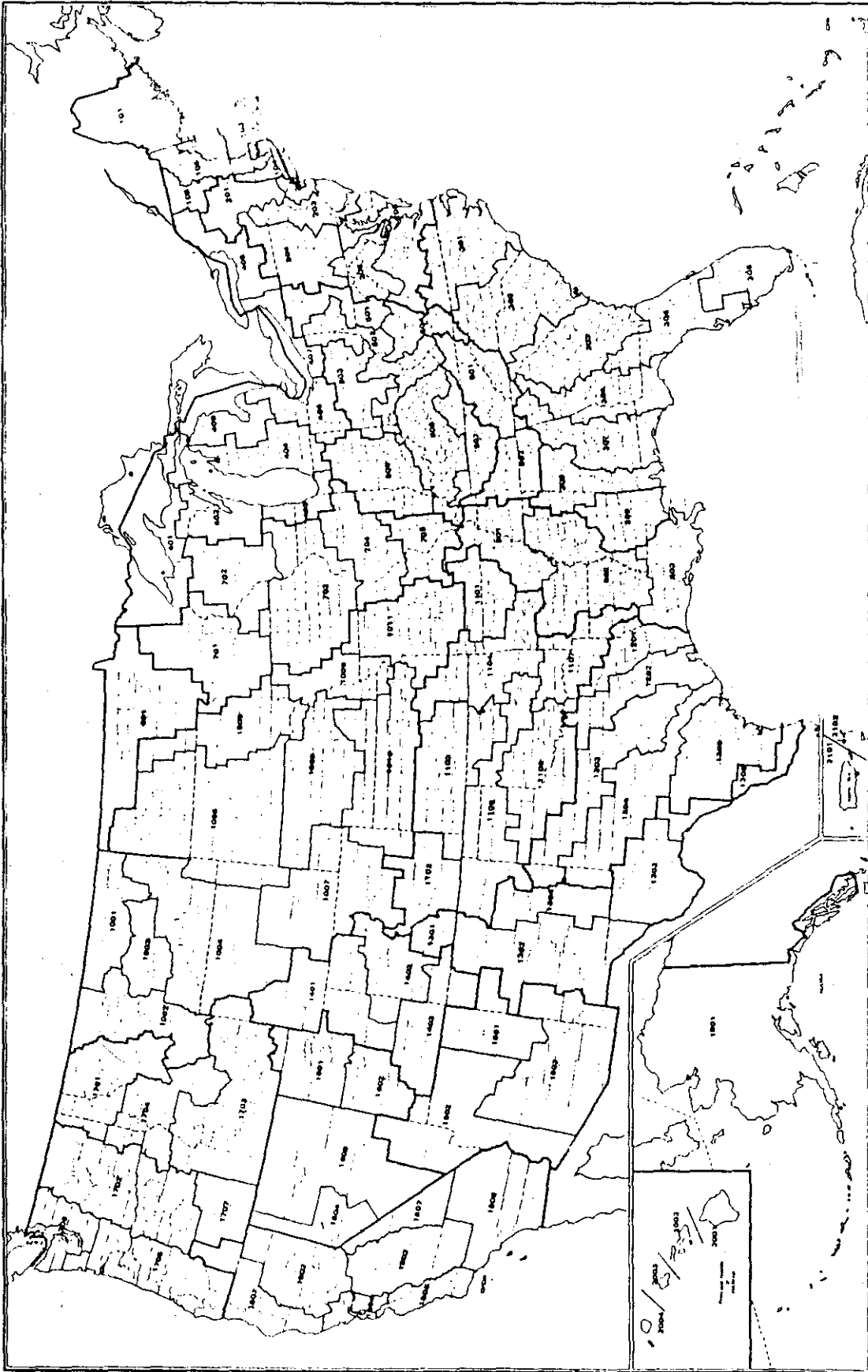


Figure 7. Assessment Subareas (county approximations of assessment subregions)

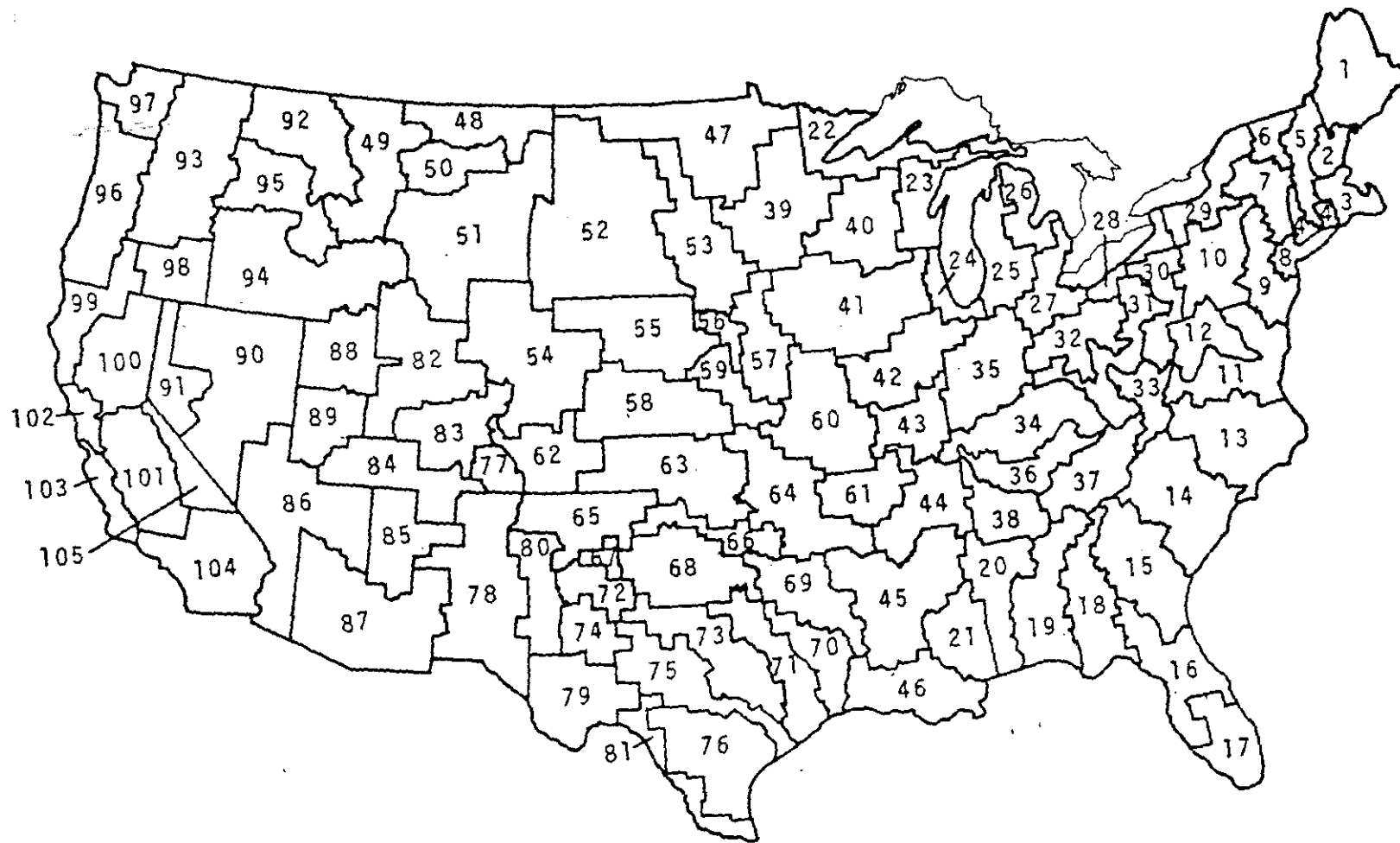


Figure 3. The 105 Producing Areas



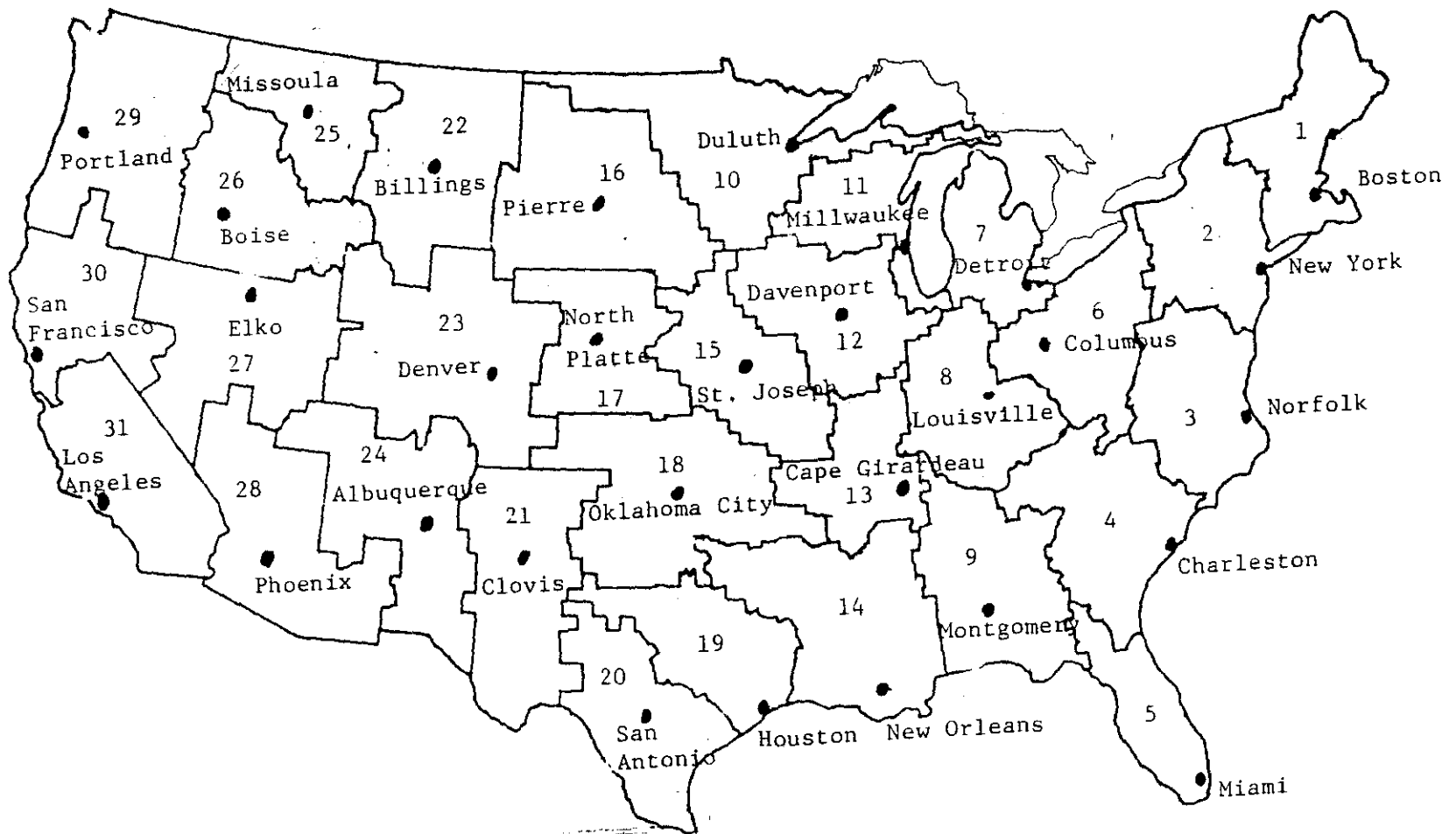


Figure 4. The 31 market regions

### Range forest regions

Range and forest activities will be based on the 34 ecosystems referred to earlier.

### Major Assumptions in Creation of the Crop and Livestock Sectors

#### Crop

Before examining the assumptions required to construct a crop sector, some terms must be defined.

1. Rotation is defined as a sequence of crops.
2. Conservation practices include straight row, contour, strip crop, and terracing. It is assumed that strip cropping cannot occur unless at least 25 percent of a rotation is in hay. In addition, it is assumed that terraces are built on the contour.
3. Tillage practices incorporate fall plow, spring plow, reduced tillage, and no-till. Reduced tillage is defined as a tillage practice leaving some residue on the ground year around.
4. The eight land groups are defined as aggregations of the Land Capability Class/Subclass system. The aggregations are shown in Table 1.
5. Cropping practice is defined as a single combination of rotation, conservation practice, and tillage practice on a given land group. Thus, an example of cropping practice would be 50 percent corn, 50 percent soybeans, using conventional reduced tillage conservation/tillage practice in Land Group I.

Endogenous crops that are included in the 1985 CARD/RCA model will be barley, corn, corn silage, cotton, legume hay, nonlegume hay, oats, pasture/range, peanuts, sorghum, sorghum silage, soybeans, sunflowers, and winter and spring wheat. These crops, along with the corresponding crop code numbers, are presented in Table 2. Double cropping will also be included in the programming model.

There are two basic files that EPIC requires from CARD. These files are the rotation file and the machinery complement and input file.

#### Rotation File:

The constitution of the rotation file was initiated several years ago by contacting the state SCS offices for their C-factor rotation files. From these files, a data set was constructed with over 11,000 records. Using this file and some supplemental rotations from the Applied Conservation Effects questionnaire, a rotation file was developed. The goal in creating this file was to maintain adequate crop coverage while keeping the rotation file to a manageable size. To achieve this, a set of rules was developed and are presented in Table 3.

As you will notice from these rules, we have not adequately examined sunflower rotations nor double cropped rotations. It is assumed or previously recommended by PAC to grow sunflowers in the Dakotas and Minnesota but not in other regions of the United States.

This file was verified by an agronomist located at each of the Soil Conservation Services' National Technical Center. Additional rotations were added to the file and some stricken from the file based on their recommendations.

Table 2. Rotation file crop codes

| Crop code | Crop Definition                  |
|-----------|----------------------------------|
| 1.        | Barley                           |
| 2.        | Corn                             |
| 3.        | Corn Silage                      |
| 4.        | Cotton                           |
| 5.        | Legume Hay Harvest               |
| 7.        | Oats                             |
| 8.        | Pasture                          |
| 9.        | Peanuts                          |
| 10.       | Sorghum                          |
| 11.       | Sorghum Silage                   |
| 12.       | Soybeans                         |
| 13.       | Summer Fallow                    |
| 14.       | Sunflowers                       |
| 15.       | Spring Wheat                     |
| 16.       | Winter Wheat                     |
| 17.       | Establish Legume Hay             |
| 18.       | Establish Non-legume Hay         |
|           | a                                |
| 81.       | Winter Wheat - Soybeans DC       |
| 82.       | Non-legume Hay - Winter Wheat DC |
| 83.       | Sorghum - Winter Wheat DC        |
| 84.       | Corn - Sunflowers DC             |
| 85.       | Corn - Sorghum DC                |
| 86.       | Sorghum - Soybeans DC            |
| 87.       | Corn - Soybeans DC               |
| 88.       | Wheat - Peanuts DC               |
| 89.       | Sorghum - Oats DC                |
| 90.       | Oats - Soybeans DC               |
| 91.       | Oats - Peanuts DC                |
| 92.       | Barley - Soybeans DC             |
| 93.       | Barley - Corn Silage DC          |
| 94.       | Winter Wheat - Corn Silage DC    |
| 95.       | Barley - Sorghum DC              |
| 96.       | Barley - Corn DC                 |

a

DC indicates double cropping (two crops in one year). The crop sequence is as expressed in the table.

Table 3. Rotation selection rules

- 
1. Continuous rotations for HLH and NLH shall be included in all MLRAs.
  2. If over 20 percent of the acreage in a given PA is in a single crop, then a continuous crop rotation for that crop is to be included in the MLRA.
  3. At this point, keep all double cropping rotations.
  4. Eliminate all rotations with winter cover. If winter cover is desired, it will be treated as a different conservation practice.
  5. If more than 1 percent of the acreage within a given MLRA is planted in a given crop, then that crop must appear in 3 or more rotations.
  6. All sunflower rotations are to be kept.
  7. All minor crops (minor to a MLRA is defined as less than 1 percent) shall be represented in at least one rotation. However, if it is less than .05 percent, then it is assumed not to exist.
  8. If a rotation is greater than 6 years, then it is not included.
  9. If a rotation is greater than 5 years and has 4 years of contiguous crop, then it is not included. Example: corn, corn, hay, hay, hay.
  10. Keep the number of rotations below 20 rotations in a given MLRA. Do not count double crop or sunflower rotations at this point.
-

This file was then converted to a PA file by assigning MLRAS to PAs (Appendix A). This file was then checked based on the criteria presented in Table 3.

Machinery complement and other input file:

Crop and tillage practice machinery complements and input requirements were obtained from the SCS state offices. These complements were placed on a state based computerized data set. Once coded, these budgets were assigned to the RCA MLRAS and sent back to the states for review.

After the first review, the budgets were then sent to the National Technical Centers so that missing budgets (based on the needs of the MRLA rotation file) could be built. During this check, consistency between tillage practices was also conducted using the definitions in Table 4 and mixing efficiencies described in Table 5. The Technical Centers' personnel

Table 4. Tillage definitions used in the RCA analysis

| Tillage practices    | Definition   |
|----------------------|--|
| No till              | More than 70 percent residue cover after planting      |
| Conservation Tillage | Between 70 and 30 percent residue cover after planting |
| Conventional Tillage | Less than 30 percent residue cover after planting      |

then examined those budgets that did not meet the tillage definition. They adjusted the tillage complement so that the definition would be met, or in some cases the mixing efficiency was altered to reflect present farming practices.<sup>1</sup>

<sup>1</sup>The mixing efficiency assumed in Table 5 represents a maximum mixing efficiency. Since the objective of conservation tillage is to leave some residue on the ground, equipment could be adjusted so that the efficiency was reduced.

Table 5. Mixing efficiencies assumed in estimating residue incorporation

| Equipment            | Mixing efficiency<br>-----percent----- |
|----------------------|--|
| Tandem disk          | .500                                   |
| Offset disk          | .600                                   |
| Oneway disk          | .700                                   |
| Moldboard plow       | .900                                   |
| Chisel plow          | .400                                   |
| Subsoiler            | .300                                   |
| Bedder/lister        | .800                                   |
| Field cultivator     | .400                                   |
| Row crop cultivator  | .500                                   |
| Harrow-springtooth   | .200                                   |
| Harrow-spike         | .200                                   |
| Rotary hoe           | .100                                   |
| Seed bed conditioner | .100                                   |
| Roller harrow        | .050                                   |
| Culti-packer         | .050                                   |
| Tandem packer        | .050                                   |
| Stubble mulcher      | .100                                   |
| Rodweeder            | .050                                   |
| Anhy Appl            | .150                                   |
| Drill                | .250                                   |
| No till drill        | .100                                   |
| Cultipack seeded     | .050                                   |
| Sandfighter          | .100                                   |
| Boarder Disk         | .600                                   |
| Furrower             | .200                                   |
| Row planter          | .050                                   |
| Min-till planter     | .150                                   |
| Lister planter       | .800                                   |
| Rock picker          | .150                                   |

Table 5 (continued)

| Equipment            | Mixing efficiency |
|----------------------|-------------------|
| Landplane            | .500              |
| Scraper              | .500              |
| Roto-tiller          | .600              |
| Ditcher              | .050              |
| Peanut digger        | .500              |
| Oneway disk          | .700              |
| Moldboard plow       | .900              |
| Bedder/lister        | .800              |
| Chisel plow          | .400              |
| Subsoiler            | .300              |
| Tandem disk          | .500              |
| Offset disk          | .600              |
| Field cultivator     | .400              |
| Roto-tiller          | .600              |
| Harrow-springtooth   | .200              |
| Harrow-spike         | .200              |
| Seed bed conditioner | .100              |
| Roller harrow        | .050              |
| Culti-packer         | .050              |
| Tandem packer        | .050              |
| Stubble mulcher      | .100              |
| Rodweeder            | .050              |
| Sandfighter          | .100              |
| Boarder disk         | .600              |
| Furrower             | .200              |
| Rock picker          | .150              |
| Landplane            | .500              |
| Scraper              | .500              |
| Ditcher              | .050              |
| Row crop cultivator  | .500              |



Table 5 (continued)

| Equipment        | Mixing efficiency |
|------------------|-------------------|
| Rotary hoe       | .100              |
| Anhy appl        | .150              |
| Peanut digger    | .500              |
| Drill            | .250              |
| No till drill    | .100              |
| Cultipack seeder | .050              |
| Row planter      | .050              |
| Min-till planter | .150              |
| Lister planter   | .800              |

Data requirements for yield sector:

One of the most important data sets in the Center for Agricultural and Rural Development, Soil and Water Resources Conservation Act's family of models (CARD/RCA) is the crop sector. The crop sector requires information on yields,\* nitrogen,\* phosphorus,\* potassium,\* and energy use (electricity, diesel, natural gas, and LPG); irrigation water requirements;\* soil erosion\* (water and wind); and costs of production.<sup>1</sup> Information for the items with an \* can, for the most part, be derived from EPIC. This portion of the paper addresses the transformations required to use EPIC output information as input information in the CARD/RCA crop sector models.

EPIC can be defined as a sophisticated production function that incorporates numerous algebraic submodels which interact to simulate the values of many input and output variables of the plant growth process<sup>2</sup> (Table 6). By matching these variables to those needed by the CARD/RCA models, an information flow between EPIC and CARD/RCA can be established. The linkage of data items is presented in Table 7.

<sup>1</sup>In this paper, costs of production are defined as costs other than the costs accounted for by the endogenous variables.

<sup>2</sup>The EPIC will be run using the following assumptions:

1. An automatic fertilizer test will be conducted just after planting the crop. The soil test indicates the quantities of N and P that EPIC will apply to meet the crop's nutrient demands given the condition of the soil. One additional side dressing is applied to the field if needed.
2. Technology will be held constant in the EPIC runs. It is, therefore, assumed that a change in technology will not significantly affect the residue left on the ground.
3. A weather seed will be selected, such that no bias in yields (resulting from weather) exist over time. To find this seed, a linear regression will be performed with rainfall as the dependent variable.

$$R = a + bt$$

Table 6. Output variables from EPIC (The units of measurement are in parentheses)

---

|      |   |
|------|---|
| AOF  | = Soil loss - Onstad-Foster estimate (T/HA)                     |
| C    | = Average USLE C factor   |
| CAN  | = Crop available N (KG/HA)                                      |
| CAW  | = Crop available water (MM)                                     |
| CN   | = Average SCS runoff curve number                               |
| CROP | = Crop name   |
| DM   | = Total plant biomass (KG/HA)                                   |
| DN   | = Denitrification (KG/HA)                                       |
| DNS  | = Days of nitrogen stress (#)                                   |
| DPS  | = Days of phosphorus stress (#)                                 |
| DTS  | = Days of temperature stress (#)                                |
| DWS  | = Days of water stress (#)                                      |
| EI   | = Rainfall energy factor (T/HA*H)                               |
| EP   | = Actual plant evaporation (MM)                                 |
| ER   | = Enrichment ratio (nitrogen and phosphorus) (kg/HA)            |
| ERTH | = Eroded thickness (MM)   |
| ET   | = Actual evapotranspiration (MM)                                |
| EVN  | = NO <sub>3</sub> upward movement from soil evaporation (KG/HA) |
| FN   | = Average annual N fertilizer rate (KG/HA)                      |
| FON  | = Fresh organic N (KG/HA)                                       |
| FP   | = Average annual P fertilizer rate (KG/HA)                      |
| HRLT | = Average daily light duration (H)                              |
| HU   | = Accumulated heat units (C)                                    |
| HUM  | = Humus (T/HA)  |
| IM   | = Immobilization  |
| IMN  | = N immobilized (KG/HA)   |
| IMP  | = P immobilized (KG/HA)   |
| IRGA | = Irrigation water applied (MM)                                 |
| LAI  | = Leaf area index   |
| MN   | = Mineralization  |
| MNN  | = N mineralized (KG/HA)   |
| MNP  | = P mineralized (KG/HA)   |

Table 6. (cont.)

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|      |   |
|------|---|
| NFIX | = Nitrogen fixation (KG/HA)                       |
| PEP  | = Potential plant evaporation ?                   |
| PET  | = Potential evapotranspiration ?                  |
| PLAB | = Labile P present in soil profile (KG/HA)        |
| PNS  | = Percent of nitrogen stress (%)                  |
| PPS  | = Percent of phosphorus stress (%)                |
| PRK  | = Percolation (MM)                                |
| PRKN | = NO <sub>3</sub> loss in percolate (KG/HA)       |
| PTS  | = Percent of temperature stress (%)               |
| PWS  | = Percent of water stress (%)                     |
| Q    | = Surface runoff (MM)                             |
| RAD  | = Average solar radiation (C)                     |
| RAIN | = Rainfall (MM)                                   |
| RD   | = Root depth (MM)                                 |
| RN   | = Nitrogen in rainfall (KG/HA)                    |
| RSD  | = Crop residue (KG/HA)                            |
| RTWT | = Root weight (MG)                                |
| SNOW | = Water content of snow (MM)                      |
| SSO3 | = Leached NO <sub>3</sub> ( )                     |
| SSF  | = Subsurface flow (MM)                            |
| SSFN | = NO <sub>3</sub> loss in subsurface flow (KG/HA) |
| SW   | = Total soil water in profile (MM)                |
| TMN  | = Average minimum temperature (C)                 |
| TMP  | = Average temperature in third soil layer (C)     |
| TMX  | = Average maximum temperature (C)                 |
| TNO3 | = NO <sub>3</sub> present in soil profile (KG/HA) |
| UNO3 | = N uptake by crop (KG/HA)                        |
| UPP  | = P uptake by crop (KG/HA)                        |
| USLE | = Soil loss - USLE estimate (T/HA)                |
| WDIR | = Average wind direction (clockwise RAD from N)   |
| WVL  | = Average wind velocity (M/S)                     |
| Y    | = Soil loss - MUSLE estimate (T/HA)               |

Table 6. (cont.)

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|      |  |
|------|--|
| YAP  | = Soluble P loss (KG/HA)               |
| YEAR | = Year of simulation (yr.)             |
| YLD  | = Crop yield (KG/HA)                   |
| YN   | = Yield organic nitrogen ( ' )         |
| YN03 | = NO3 loss in surface runoff (KG/HA)   |
| YON  | = Organic N loss with sediment (KG/HA) |
| YP   | = P loss with sediment (KG/HA)         |
| YPA  | = Available phosphorus ( ' )           |
| YW   | = Soil loss from wind erosion (T/HA)   |

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Table 7. Data needs in the crop sector of the CARD/RCA model family and the source to be used in filling these needs

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| Crop sector variables | Variable from EPIC   | Other Sources     |
|-----------------------|--|-------------------|
| Rotation              | CROP   |                   |
| Yields                | YLD <sup>a</sup> , DM                                      |                   |
| Fertilizers:          |  |                   |
| N                     | FN <sup>a</sup> UNO3                                       |                   |
| P                     | FP <sup>a</sup> UPP  |                   |
| K                     |  | FEDs <sup>b</sup> |
| Energy Use:           |  |                   |
| Diesel                |  | FEDs              |
| Electricity           |  | FEDs              |
| Natural gas           |  | FEDs              |
| LPG                   |  | FEDs              |
| Soil loss:            |  |                   |
| USLE                  | USLE <sup>a</sup>  |                   |
| Other water           | AOF <sup>ac</sup> , Y <sup>ac</sup> , ERT <sup>H</sup> , Q |                   |
| Wind                  | YW <sup>a</sup>  |                   |
| Costs                 |  | FEDs              |
| Residue               | RSD  |                   |

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<sup>a</sup>This is the variable to be used or transformed in the CARD model. The other variables will be carried along for future analysis.

<sup>b</sup>Firm Enterprise Data System

<sup>c</sup>If one of these two variables is selected as the soil erosion driver, it will be used in the LP and the USLE will be carried along.

The yield data derived from EPIC consist of four yield adjustments (Putman, Dyke, 1985). A yield index is provided for each crop by RCA land group in each MLRA (Table 8). This yield index is adjusted, based on the crop previously produced, on the tillage practice, and on the amount of erosion that has occurred.<sup>1</sup> Therefore, a unique yield exists for each crop year within the cropping practice.

Since the data described above incorporates yield indexes and not actual yields, MLRA yields are derived from the Statistical Research Service's county data base. Average county yields are derived over the years 1979, 1980, and 1981 and aggregated to MLRA.

An example of the steps involved in this is shown below for MLRA 109. Assume that the cropping practice is a corn, corn, soybeans rotation on the land employing reduced tillage and strip cropping. To estimate the yield for this cropping practice, seven items are required:

1. Yield index for all RCA land group in the MLRA;
2. Land in corn and soybeans in MLRA 109 by land group;
3. Average yield for both corn and soybeans;
4. Tillage yield adjustment for both corn and soybeans;
5. Crop sequence yield adjustment for corn following corn, corn following soybeans, and soybeans following corn;
6. Yield adjustment due to erosion;
7. The amount of accumulated erosion.

Items 1 and 2 are presented in Table 8. By multiplying the yield index by quantity of land in corn in each land group, a proxy for

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<sup>1</sup>No adjustment for conservation practice is made.

Table 8. Corn and soybean yield indexes and quantity of land by land group for MLRA 109

| RCA land group | Corn yield index | Quantity of land in corn (acres) | Proxy production (index & acres) | Adjusted corn yield index | Soybean yield index | Quantity of land in soybeans (acres) | Proxy production (index & acres) | Adjusted soybeans yield index |
|----------------|------------------|----------------------------------|----------------------------------|---------------------------|---------------------|--------------------------------------|----------------------------------|-------------------------------|
| 1              | 1.0483           | 281.4                            | 295.0                            | 1.1213                    | 1.0596              | 421.8                                | 446.9                            | 1.1428                        |
| 2              | 1.0000           | 169.6                            | 169.6                            | 1.0697                    | 1.0000              | 241.2                                | 241.2                            | 1.0786                        |
| 3              | 0.8082           | 435.3                            | 351.8                            | 0.8645                    | 0.7877              | 659.8                                | 519.7                            | 0.8496                        |
| 4              | 0.8830           | 143.3                            | 126.5                            | 0.9413                    | 0.8927              | 129.4                                | 115.5                            | 0.9628                        |
| 5              | NA               | NA                               | NA                               | NA                        | NA                  | 0.0                                  | 0.0                              | NA                            |
| 6              | 0.7500           | 7.5                              | 5.6                              | 0.8022                    | 0.7500              | 10.0                                 | 7.5                              | 0.8089                        |
| 7              | 1.0500           | 219.90                           | 230.9                            | 1.1231                    | 1.0500              | 223.10                               | 234.3                            | 1.1325                        |
| 8              | 6.8680           | 63.7                             | 55.3                             | 0.9285                    | 0.8487              | 49.3                                 | 43.1                             | 0.9434                        |
| Total          |                  | 1320.7                           | 1234.7                           |                           |                     | 1734.6                               | 1608.3                           |                               |

<sup>a</sup>Proxy yields

$$\frac{1320.7}{1234.7} = 1.06965$$

$$\frac{1734.6}{1608.3} = 1.07856$$

production is determined. When this is summed over the eight land groups and divided by acres, the result should equal one. If the result is less than one, the yield index is too low. In Table 7, the third and seventh columns illustrate the proxy "production" calculations with the adjusted corn and soybean indexes illustrated in columns 4 and 8. These indexes provide a base corn/soybean yield for a given land group. Assuming 89 and 27 bushels per acre corn and soybean yield per acre, respectively, the corn (soybean) base yield for Land Group 4 (IVE) is 83.8 (26.0) bushels per acre.

The next step is to adjust for crop sequence. Using a corn, corn, soybeans rotation, three different crop sequences can be specified: corn after corn, soybeans after corn, and corn after soybeans. Utilizing the information in Table 9, we find yield for these three sequences to be:

|                         |                            |
|-------------------------|----------------------------|
| for corn after corn     | 83.8 times 1.1306 = 94.7;  |
| for soybeans after corn | 26 times 1.041 = 27.1; and |
| for corn after soybeans | 83.8 times 1.0219 = 85.6.  |

Therefore, an acre of land in this rotation with 2/3 corn and 1/3 soybeans would yield 60.1 bushels of corn and 9 bushels of soybeans.

The final adjustment is attributed to the tillage practice employed. In an example, a conservation tillage practice is assumed. Under this practice, corn yield is reduced by multiplying 60.1 bushels of corn by 0.9988, a reduction of 0.1 bushels (Table 10 soybean yield on the acre of land is also approximately 0.1 bushels).

The next step is to adjust for future yields. The first step is to increment the 1980 yields upward because of the estimated technology impacts. From Table 11, the projected yield for corn in the year 2030 is assumed to be 40 percent above the 1980 level and for soybeans, 60



Table 9. Yield adjustments for crop sequences, including corn and soybeans for MLRA 109

| Crop sequence           | Yield adjustment |
|-------------------------|------------------|
| Corn after corn         | 1.1306           |
| Corn after legume hay   | 1.0486           |
| Corn after grass hay    | 1.0626           |
| Corn after soybeans     | 1.0219           |
| Corn after wheat        | 1.0000           |
| Soybeans after corn     | 1.0410           |
| Soybeans after soybeans | 1.0000           |

Table 10. Tillage adjustment for corn and soybean yields for MLRA 109

| Tillage practice     | Corn   | Soybeans |
|----------------------|--------|----------|
| No winter cover      | 1.0117 | 0.9978   |
| Winter cover         | 1.0000 | 1.0000   |
| Conservation tillage | 0.9988 | 0.9886   |
| No-tillage           | 0.9924 | 0.9851   |

Table 11. Projected yields assumed in the 1985 RCA analysis

| Crop                | 2000              | 2030 |
|---------------------|-------------------|------|
|                     | -----percent----- |      |
| Feed grains         | 40                | 100  |
| Hay                 | 20                | 50   |
| Wheat <sup>a</sup>  | 50                | 100  |
| Cotton <sup>b</sup> | 50                | 50   |
| Soybeans            | 60                | 120  |

<sup>a</sup>Farm production regions (Southern Plains, Northern Plains, and Mountain) will have yield gains 10 percent below the national gain in in yields by 2000 and 20 percent below by 2030.

<sup>b</sup>Cotton yield projection for the San Joaquin Valley and the Pacific Region are 10 percent higher than the national levels.

percent higher. Therefore, the base yield on 2030 will be 120.2 bushels of corn on 2/3 of an acre (180 bu./acre) and 19.6 bushels of soybeans on the remaining 1/3 of an acre (59 bu./acre).

The last adjustment to yields because of erosion must now be made. The first step in this process is to determine the erosion levels. From Table 12, we find the levels of erosion for strip cropping using conservation tillage methods. Again, for each of the three crop sequences the values are reported in Table 13.

Accumulating the tons lost over 50 years for corn after soybeans, 1,119.0 tons of soil or approximately 7 inches of top soil is lost over the 50 year period. The next step is to use this accumulated soil lost in estimating the erosion impact. As reported from regression models developed at Temple, Texas by Putman, Dyke, and Wistrand (1984),

Table 12. Erosion level<sup>a</sup> on 4e land (Land Group 4) in MLRA 109 for selected crop sequences by conservation and tillage practice

| Crop sequence        | Straight row                 | Contour            | Strip cropping | Terracing |
|----------------------|------------------------------|--------------------|----------------|-----------|
|                      | -----tonnes per hectare----- |                    |                |           |
| Corn after corn:     |                              |                    |                |           |
| No winter cover      | 60.78                        | 60.78 <sup>b</sup> | 36.47          | 35.71     |
| Winter cover         | 42.82                        | 42.82              | 25.69          | 25.16     |
| Conservation tillage | 31.77                        | 31.77              | 19.06          | 18.67     |
| No-till              | 5.33                         | 5.33               | 3.32           | 3.25      |
| Corn after soybeans: |                              |                    |                |           |
| No winter cover      | 69.07                        | 69.07              | 41.44          | 40.58     |
| Winter cover         | 48.35                        | 48.35              | 29.01          | 28.41     |
| Conservation tillage | 37.30                        | 37.30              | 22.38          | 21.91     |
| No-till              | 5.53                         | 5.53               | 3.32           | 3.25      |
| Soybeans after corn: |                              |                    |                |           |
| No winter cover      | 66.30                        | 66.30              | 39.78          | 38.96     |
| Winter cover         | 51.11                        | 51.11              | 30.67          | 30.03     |
| Conservation tillage | 35.92                        | 35.92              | 21.55          | 21.10     |
| No-till              | 5.53                         | 5.53               | 3.32           | 3.25      |

<sup>a</sup>Assumes AOE measure of erosion.

<sup>b</sup>The contour cropping p factor is the same as straight row practices under this land group in this MLRA. Hence, there is no change in erosion levels.

Table 13. Annual and accumulated erosion levels for selected crop sequences in MLRA 107

| Crop sequence       | Annual erosion <sup>a</sup> | 20 years erosion | 50 years erosion |
|---------------------|-----------------------------|------------------|------------------|
|                     | -----tons/acre-----         |                  |                  |
| Corn after corn     | 19.06                       | 381.2            | 953.0            |
| Corn after soybeans | 22.38                       | 447.6            | 1,119.0          |
| Soybeans after corn | 21.55                       | 431.0            | 1,077.5          |

<sup>a</sup> Assume AOE measure of erosion.

impacts for corn and soybeans in MLRA 109 are reported in Table 14. For the above example, corn yields would be reduced 0.028 bushels in the corn after corn sequence, 0.033 bushels in the corn after soybeans sequence, and 0.031 bushels of soybeans in the soybean after corn sequences. Clearly, erosion has a rather slight impact to crop productivity in this example.

We have only accounted for yield impacts, however. The next step is to quantify the nitrogen and phosphorus needs for this rotation.

Presently, our yields by crop sequence on a per acre basis are:

|                     |                        |
|---------------------|------------------------|
| Corn after corn     | 189.2 bushels per acre |
| Corn after soybeans | 171.2 bushels per acre |
| Soybeans after corn | 58.9 bushels per acre  |

Using the information provided in Table 15 for Land Group 4, the following per acre nitrogen and phosphorus needs are projected to be:

Table 14. Yield impact coefficients as a result of erosion

| Land group | Corn                   | Soybeans               |
|------------|------------------------|------------------------|
| 2          | $2.69 \times 10^{-5}$  | $2.542 \times 10^{-5}$ |
| 3          | $1.196 \times 10^{-5}$ | $1.179 \times 10^{-5}$ |
| 4          | $1.3 \times 10^{-5}$   | $1.34 \times 10^{-5}$  |
| 5          | NA                     | NA                     |
| 6          | $7.468 \times 10^{-5}$ | $1.164 \times 10^{-5}$ |
| 7          | $2.356 \times 10^{-5}$ | $1.952 \times 10^{-5}$ |
| 8          | $1.975 \times 10^{-5}$ | $1.488 \times 10^{-5}$ |

|                     | Nitrogen | Phosphorus |
|---------------------|----------|------------|
| Corn after corn     | 238.4    | 62.4       |
| Corn after soybeans | 282.5    | 78.8       |
| Soybeans after corn | 0.0      | 42.4       |

Once these are projected, additional nitrogen needs caused by erosion of the surface layers of soil must be computed. These are presented in Table 16. These coefficients when multiplied by accumulated tonnes per hectare will determine additional nutrient needs of the plant caused by erosion. For corn, this coefficient is  $2,241 * 1.32 + 10^{-5} * 1,119.0$  for the corn after soybean sequence. This additional nitrogen requirement for corn on this acre of land is  $2,819.1 * 10^{-5} + 3,310.1 * 10^{-5}$  times the two-thirds of an acre that corn is grown on. Since soybeans require 0 nitrogen, this results in an additional nitrogen requirement of 0.06 pounds per acre. Similar calculations are conducted for phosphorous.

Table 15. Nitrogen and phosphorus requirements by land group for MLRAs 102A, 102B, 103, 104, 105, 106, 107, 108, 109, 110, 111, 112, 113, 114, and 115

|                           | Land Group                          |      |      |      |    |      |      |      |
|---------------------------|-------------------------------------|------|------|------|----|------|------|------|
|                           | 1                                   | 2    | 3    | 4    | 5  | 6    | 7    | 8    |
|                           | -----pounds of nitrogen/bushel----- |      |      |      |    |      |      |      |
| Corn after corn           | 1.02                                | 1.11 | 1.15 | 1.26 | NA | 1.09 | 1.03 | 1.53 |
| Corn after legume hay     | 1.10                                | 1.27 | 1.32 | 1.41 | NA | 1.24 | 1.22 | 1.56 |
| Corn after nonlegume hay  | 1.00                                | 1.28 | 1.32 | 1.45 | NA | 1.20 | 1.16 | 1.61 |
| Corn after soybeans       | 1.22                                | 1.33 | 1.40 | 1.65 | NA | 1.38 | 1.26 | 1.91 |
| Corn after sorghum silage | 1.21                                | 1.37 | 1.46 | 1.54 | NA | 1.33 | 1.33 | 1.80 |
| Corn after wheat          | 0.82                                | 1.18 | 1.21 | 1.26 | NA | 1.08 | 1.06 | 1.41 |
| Soybeans after corn       | 0.0                                 | 0.0  | 0.0  | 0.0  | NA | 0.0  | 0.0  | 0.0  |
| Soybeans after soybeans   | 0.0                                 | 0.0  | 0.0  | 0.0  | NA | 0.0  | 0.0  | 0.0  |
|                           | -----pounds of phosphorus-----      |      |      |      |    |      |      |      |
| Corn after corn           | 0.43                                | 0.43 | 0.39 | 0.33 | NA | 0.60 | 0.37 | 0.55 |
| Corn after legume hay     | 1.09                                | 1.12 | 1.00 | 1.05 | NA | 0.96 | 1.13 | 1.05 |
| Corn after nonlegume hay  | 0.39                                | 0.35 | 0.31 | 0.45 | NA | 0.30 | 0.36 | 0.42 |
| Corn after soybeans       | 0.59                                | 0.53 | 0.52 | 0.46 | NA | 0.48 | 0.53 | 0.50 |
| Corn after sorghum silage | 0.49                                | 0.48 | 0.47 | 0.41 | NA | 0.43 | 0.46 | 0.57 |
| Corn after wheat          | 0.40                                | 0.46 | 0.46 | 0.44 | NA | 0.42 | 0.39 | 0.46 |
| Soybeans after corn       | 0.30                                | 0.28 | 0.33 | 0.34 | NA | 0.39 | 0.28 | 0.46 |
| Soybeans after soybeans   | 0.87                                | 0.82 | 0.75 | 0.72 | NA | 0.83 | 0.85 | 0.92 |

Table 16. Additional nitrogen and phosphorus needs coefficient

| Land group | Corn                             |                                    |                              | Soybeans                           |
|------------|----------------------------------|------------------------------------|------------------------------|------------------------------------|
|            | Nitrogen impact<br>( $10^{-5}$ ) | Phosphorus impact<br>( $10^{-5}$ ) | Lime impact<br>( $10^{-5}$ ) | Phosphorus impact<br>( $10^{-5}$ ) |
| 1          | 0.0                              | 0.0                                | 0.0                          | 0.0                                |
| 2          | 3.93                             | 9.22                               | 8.50                         | 37.70                              |
| 3          | 1.36                             | 5.56                               | 8.89                         | 9.52                               |
| 4          | 1.32                             | 5.56                               | 7.64                         | 10.53                              |
| 5          | NA                               | NA                                 | NA                           | NA                                 |
| 6          | 0.0                              | 0.0                                | 0.0                          | 0.0                                |
| 7          | 0.0                              | 0.0                                | 0.0                          | 0.0                                |
| 8          | 1.57                             | 15.80                              | 4.27                         | 8.30                               |

| Producing Area | MLRA Assignment | State Assignment  | Producing Area | MLRA Assignment | State Assignment |
|----------------|-----------------|-------------------|----------------|-----------------|------------------|
| 1              | 143             | Maine             | 25             | 98              | Michigan         |
| 2              | 144B            | New Hampshire     | 26             | 94A             | Michigan         |
| 3              | 144A            | Mass.             | 27             | 99              | Michigan         |
| 4              | 144A            | Conn.             | 28             | 139             | Ohio             |
| 5              | 144B            | Vermont           | 29             | 101             | New York         |
| 6              | 142             | Vermont           | 30             | 127             | Penn             |
| 7              | 143             | New York          | 31             | 126             | Ohio             |
| 8              | 149A            | New Jersey        | 32             | 111             | Ohio             |
| 9              | 148             | Penn.             | 33             | 128N            | West Virginia    |
| 10             | 140             | Penn.             | 34             | 120             | Kentucky         |
| 11             | 136             | Virginia          | 35             | 111             | Indiana          |
| 12             | 147             | W. Virginia/Mary. | 36             | 122             | Tennessee        |
| 13             | 153A            | N. Carolina       | 37             | 128             | Tennessee        |
| 14             | 133A            | S. Carolina       | 38             | 123             | Tennessee        |
| 15             | 136             | Georgia           | 39             | 103             | Minnesota        |
| 16             | 154             | Florida           | 40             | 90              | Wisconsin        |
| 17             | 156A            | Florida           | 41             | 108             | Iowa             |
| 18             | 133A            | Georgia           | 42             | 115             | Illinois         |
| 19             | 133A            | Alabama           | 43             | 114             | Illinois         |
| 20             | 135             | Alabama           | 44             | 134             | Arkansas         |
| 21             | 133A            | Mississippi       | 45             | 133B            | Louisiana        |
| 22             | 93              | Minnesota         | 46             | 151             | Louisiana        |
| 23             | 95A             | Wisconsin         | 47             | 56              | N. Dakota        |
| 24             | 110             | Illinois          | 48             | 52              | Montana          |



| Producing Area | MLRA Assignment | State Assignment | Producing Area | MLRA Assignment | State Assignment |
|----------------|-----------------|------------------|----------------|-----------------|------------------|
| 49             | 43              | Montana          | 73             | 85              | Texas            |
| 50             | 58A             | Montana          | 74             | 77              | Texas            |
| 51             | 58B             | Wyoming          | 75             | 81              | Texas            |
| 52             | 54              | N. Dakota        | 76             | 83A             | Texas            |
| 53             | 55B             | S. Dakota        | 77             | 51              | Colorado         |
| 54             | 67              | Colorado         | 78             | 42              | New Mexico       |
| 55             | 65              | Nebraska         | 79             | 42              | Texas            |
| 56             | 102B            | Nebraska         | 80             | 70              | New Mexico       |
| 57             | 107             | Nebraska         | 81             | 83B             | Texas            |
| 58             | 73              | Kansas           | 82             | 34              | Wyoming/Colorado |
| 59             | 75              | Nebraska         | 83             | 48A             | Colorado         |
| 60             | 109             | Missouri         | 84             | 35              | Utah             |
| 61             | 116A            | Arkansas         | 85             | 35              | Arizona          |
| 62             | 69              | Colorado         | 86             | 30              | Arizona          |
| 63             | 78              | Kansas           | 87             | 40              | Arizona          |
| 64             | 112             | Oklahoma         | 88             | 28A             | Utah             |
| 65             | 77              | Texas            | 89             | 28A             | Utah             |
| 66             | 84              | Oklahoma         | 90             | 28B             | Nevada           |
| 67             | 77              | Texas            | 91             | 23              | Nevada           |
| 68             | 78              | Oklahoma         | 92             | 43              | Idaho            |
| 69             | 133B            | Texas            | 93             | 8               | Washington       |
| 70             | 133B            | Texas            | 94             | 11              | Idaho            |
| 71             | 87              | Texas            | 95             | 43              | Idaho            |
| 72             | 77              | Texas            | 96             | 3               | Oregon           |

| Producing<br>Area | MLRA<br>Assignment | State<br>Assignment |
|-------------------|--------------------|---------------------|
| 97                | 3                  | Washington          |
| 98                | 23                 | Oregon              |
| 99                | 5                  | California          |
| 100               | 21                 | California          |
| 101               | 17                 | California          |
| 102               | 15                 | California          |
| 103               | 15                 | California          |
| 104               | 30                 | California          |
| 105               | 26                 | California          |